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U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service

## A Guide to the Collection and Identification of Presmolt Pacific Salmon in Alaska with an Illustrated Key

MILTON B. TRAUTMAN

SEATTLE, WA  
NOVEMBER 1973



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# A Guide to the Collection and Identification of Presmolt Pacific Salmon in Alaska with an Illustrated Key

MILTON B. TRAUTMAN<sup>1</sup>

## ABSTRACT

This field and laboratory key contains recommendations for types of equipment needed, instructions for preserving and labeling specimens, and descriptions of the characters used in identifying five species of Pacific salmon. The key is illustrated with six line figures: 1) juvenile salmon, 2) the first gill arch, 3) head with gill arch in situ, 4) first gill arch and eye for comparison with longest rakers, 5) method of counting anal fin rays, and 6) ventral surface of head showing branchiostegals. Five plates of stippled line drawings of five lengths (25 to 110 mm fork length) for each of the five species of Pacific salmon, an annotated opposable key, and a glossary are also included.

## INTRODUCTION

As adults, the five species<sup>2</sup> of Pacific salmon of the genus *Oncorhynchus* inhabiting western North American waters are easily identified, but as subadults or as smolts in silvery coloration, they are less easily recognized. As juveniles less than 125 mm (5 inches) in fork length (FL), they may be quite difficult to identify. In addition, characters by which presmolt juveniles can be distinguished may vary with geographic area.

Several keys for identification of juvenile salmon have been published, most of which utilize the number, length, and shape of the gill rakers on the first gill arch; number of pyloric caeca and branchiostegals; and absence of parr marks, or if present, their size and shape (Foerster and Pritchard, 1935; Schultz, 1936; Haig-Brown, 1947; Clemens and Wilby, 1961; McPhail and Lindsey, 1970; Wilimovsky<sup>3</sup>). In addition to

the above characters, the key in this paper emphasizes and illustrates the distribution of those chromatophores (usually melanophores) which are reliable enough to aid in the specific identification of juveniles.

This key describes the characters typical of presmolt juveniles of the five species of Pacific salmon in Alaska. The common names recommended by the American Fisheries Society (Bailey et al., 1970, p. 17) are used, despite the fact that other names appear to be in more general use. These other names are inserted in parentheses after their respective species. Trouts, Atlantic salmon (*Salmo salar*), and some other salmonoids are included in the key because of their resemblance to Pacific salmon.

Before presenting the key, it appears advisable to describe the equipment and methods I recommend for preserving specimens, labeling specimens, and counting, measuring, and removing parts of specimens, so that those not acquainted with my procedures may more accurately and quickly identify their material.

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<sup>1</sup> Professor Emeritus of Zoology, Ohio State University, Columbus, OH 43210. The author was employed in Alaska by the National Marine Fisheries Service Auke Bay Fisheries Laboratory during the summers of 1959 and 1961. The specimens were obtained and most of the drawings made at that time.

<sup>2</sup> A sixth species, *O. mason* (Brevoort), inhabits the streams of eastern Asia from the Okhotsk Sea to Formosa.

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<sup>3</sup> N. J. Wilimovsky, 1958, Provisional keys to the fishes of Alaska. On file Natl. Mar. Fish. Serv. Auke Bay Fish. Lab., Auke Bay, AK 99821.



## RECOMMENDED EQUIPMENT

*Magnifiers:* Magnification in the range of 4 to 30 will prove helpful in identification of juvenile salmon. A binocular microscope having such a range is the most satisfactory, but any type of magnifier of more than 4 power and less than 30 may be used provided it is not necessary to use one's hand to hold it—usually both hands are needed to manipulate a specimen. In the field, a binocular unit containing lenses inserted in a frame or headstrap or a jeweler's eye magnifier (especially if one wears glasses) may be used.

*Forceps:* Four or five inches long with straight or curved tips—for lifting fins, holding back gill covers, etc.

*Scalpel:* A sharp blade an inch or two long—for removing gill arches, opening body cavities, etc.

*Teasing needle:* A needle inserted in a wooden or metal handle—for separating closely set gill rakers, etc.

*Dividers:* For measuring and comparing various body parts; dividers in which one or both legs can be "broken" are the most satisfactory.

*Scissors:* About 6 inches long with the blades or cutting surface of about 1 inch.

*Ruler:* Graduated in millimeters to measure fish lengths and parts; one which includes inches also desirable.

## PRESERVING SPECIMENS

The careful preserving of specimens cannot be too strongly emphasized. Much time is lost in attempting to identify improperly preserved fishes; it is only when properly preserved that they may be rapidly and correctly identified. Frequently, juvenile salmon that have died in nets become soft, bleached, and torn. For the sake of accuracy it is better not to attempt to identify such material.

To preserve juveniles, upon capture place them in a solution of 1 part Formalin to 9 parts water. If live fishes are placed in too strong a Formalin solution, they may die with their mouths widely agape or the chromatophores may close so tightly as to be difficult to detect. If placed in too weak a Formalin solution, the fishes become bleached and soft and may decompose. If fishes are to be preserved for more than a year (or permanently),

leave them in the Formalin solution at least 1 wk and if possible no longer than 4 mo. When fish are removed from the Formalin solution, soak them in water for 24 to 48 hr; then place them in a solution containing 70% ethyl alcohol and 30% water or 35% isopropyl alcohol and 65% water.

Do not crowd or pack fishes in a container, especially if they are alive or only recently dead. Fresh fishes, if packed too tightly, will become permanently deformed upon hardening in Formalin, will be bleached where their bodies come in close contact, or will decompose. A container is too crowded if the fishes will not readily move as the container is slowly rotated or shaken. When sufficient room is allowed, identification will be facilitated because the fishes will harden without discoloring; bodies and fins will not be deformed, twisted, or broken; and the chromatophores will remain nearly or fully open.

## LABELING SPECIMENS

Labeling specimens fully and properly is of great importance; unlabeled or mislabeled specimens are of little or no value. Put the label with the specimens at the time the fishes are preserved. Label paper should remain firm when wet and should not become pulpy. Write clearly with pencil or permanent ink, recording the following data.

### Field Number

Use your own or a department number. A satisfactory method is to use the first initial of your surname or your full surname, the last two digits of the year, and your collection number. Thus, if Joe Brown in 1962 preserves his fifth collection, he writes B-62-5 or Brown-62-5; if for the Department of Salmon Investigations he writes, SI-62-5. When a departmental symbol is used, it often is desirable for the collector to add his initials or name to the label.

### Name of Water Body and Locality

Use names on standard maps. Whenever possible, avoid temporary or local names, such as



Brown's fishing camp. An example of a brief but adequate recording is: Alaska, Naknek River System, Katmai National Monument, Brooks Lake.

## Date

Include the month, day, and year and, if pertinent, the hour.

The following additional information may be needed at times.

## Method of Capture

Describe type of gear and size if significant, i.e., seine (2 cm mesh), fry net (1 cm mesh), trawl (1 cm bag), etc.

## Temperature

Measure temperature of air and/or water. If water is ice-covered, what percent?

## Other Water Conditions

If a *stream*: estimate its average width and maximum depth; if tidal and brackish, to what

extent; degree of turbidity and source—glacial silt, plankton, etc.; degree of gradient—low, moderate, or high; percentage of stream in pools, with or without current; percentage of stream in riffles, whether flow is sluggish, moderate, or swift; dominant bottom types—sand, gravel, boulders, bedrock, muck, silt, etc.; aquatic vegetation—submerged, emergent, or both (name dominant species or genera if known). If a *lake or bay*: state whether fresh, brackish, or saline; if tidal, state to what extent; estimate size and possible depth; give degree of turbidity, type of bottom, and amount and kinds of aquatic vegetation.

## Remarks

Describe anything that may aid in identification of the fishes, such as peculiar markings, habits, or habitats.

## CHARACTERS USED IN IDENTIFYING SPECIES

A juvenile salmon is shown in Figure 1 to assist in recognizing and defining the characters and the counts and measurements used when keying out a specimen.

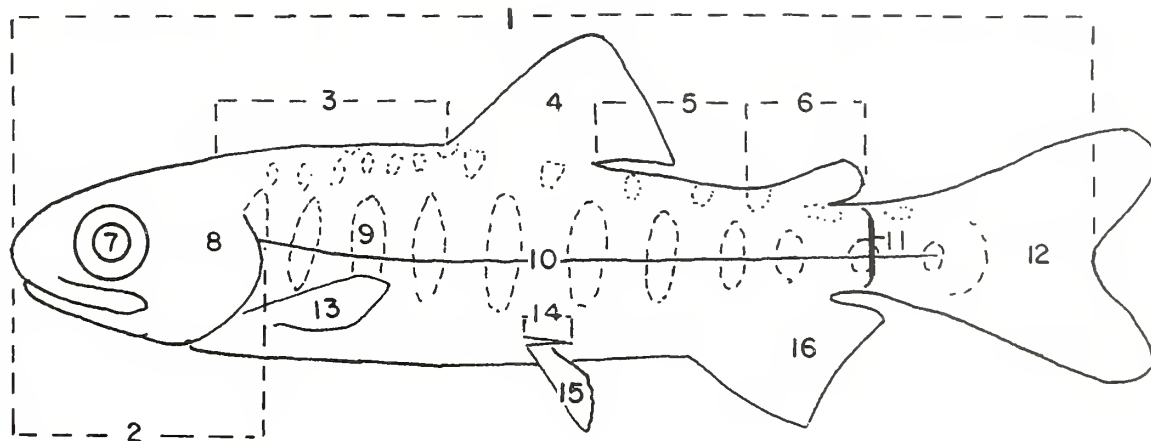
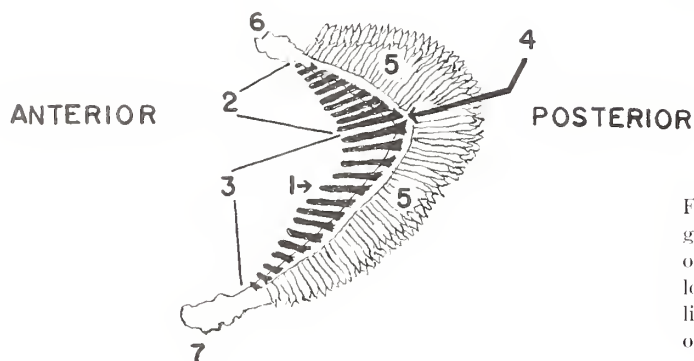


Figure 1.—Juvenile salmon, illustrating parts and methods of measuring: 1) fork length; 2) head length; 3) predorsal ridge; 4) dorsal fin; 5) portion of postdorsal ridge between posterior end of dorsal fin base and origin of adipose fin; 6) adipose fin; 7) pupil of eye; 8) gill cover, beneath which is gill chamber containing gill arches; 9) a parr mark; 10) lateral line; 11) caudal peduncle; 12) caudal fin or tail; 13) pectoral fin; 14) axillary process or scale; 15) pelvic fin; 16) anal fin.

## First Gill Arch

Beneath each gill cover are four fully formed gill arches; the first gill arch on either side is the part used for specific identification. A gill arch (Fig. 2) consists primarily of a bony central arch to which the gill rakers are attached anteriorly, the gill filaments (lamellae) posteriorly. The gill rakers prevent solid substances such as food from being carried out through the branchial clefts and protect the delicate gill filaments. The numbers of gill rakers vary somewhat among individuals of each species of salmon, but the difference in average number between some species is sufficiently great to enable one to use them as specific characters.

The rakers on the gill arch may be counted as a unit, or the upper and lower limbs may be counted separately. The two limbs are joined



at an angle, the upper being the shorter. When a raker is situated astride the angle, it is included in the lower limb count. When all of the rakers on the arch are counted as a unit, a single number is given; otherwise, both limbs are recorded separately (the upper limb first), and then added, thus  $12 + 20 = 32$ .

The gill rakers nearest the angle of the arch are the longest; the rakers become progressively shorter as they approach the attachment ends of each arch. The rakers near the ends are often rudimentary and can be counted only under magnification.

It may be difficult to count all of the rakers accurately while the first gill arch is in place, in which case it will be necessary to remove the arch. To do this, turn back or cut away gill cover as shown in Figure 3. Lift the first gill arch up-

ward. With a sharp scalpel, cut between the dorsal ends of the first and second arches, making a deep incision parallel with them; then cut the remainder of the attachment away. Next cut the ventral attachment in the same manner; and when both ends are free, remove the arch. Great care must be taken so that all rudimentary rakers may be removed and counted. After finishing the examination of the arch, reinsert it in the gill chamber for possible future examination.

## Gill Raker and Eye Comparison

The longest rakers are compared with the length of the eye (Fig. 4). With dividers, obtain the measurement of the length of the longest raker; then place one point of the dividers at the anterior edge of the eye, the other extending

Figure 2.—First gill arch of salmon after removal from left gill chamber: 1) gill raker; 2) gill rakers attached to upper or shorter limb of arch; 3) gill rakers attached to lower or longer limb of arch; 4) angle of arch (junction of the two limbs or bones); 5) gill filaments (lamellae); 6) upper point of arch attachment; 7) lower point of arch attachment.

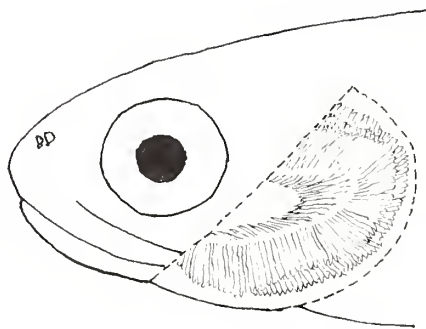
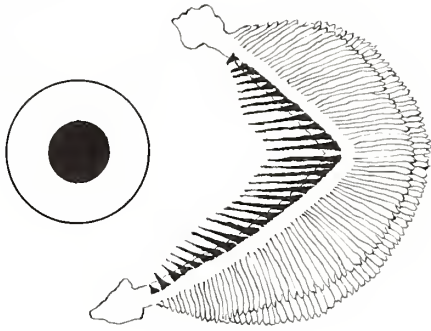
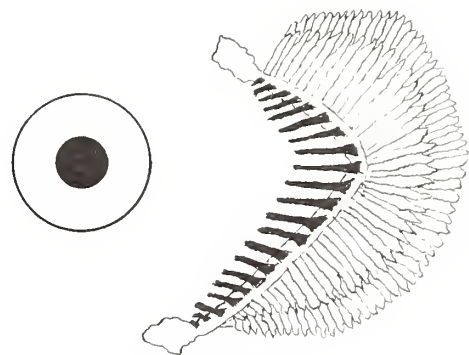


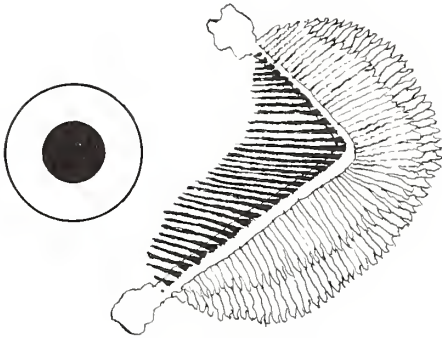
Figure 3.—Head of salmon. Dotted lines indicate that portion of gill cover which has been removed to show first gill arch in place.



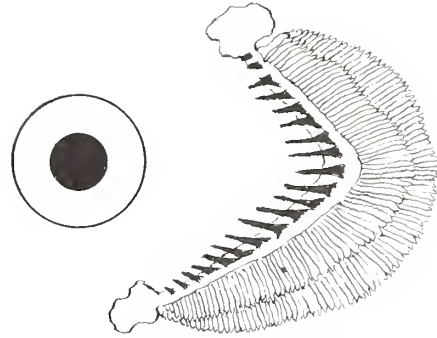
PINK



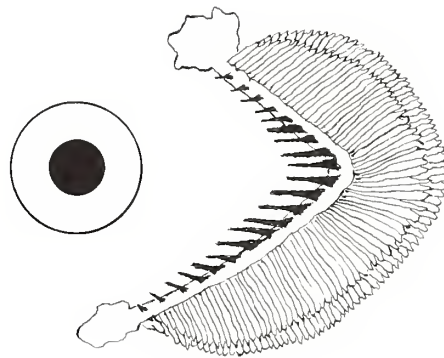
CHUM



SOCKEYE



CHINOOK



COHO

Figure 4. — First gill arch and eye for comparison with longest gill raker length of five species of Pacific salmon.

toward the opposite edge. Because the raker is shorter than the eye length in juvenile salmon, it is simplest to note where the raker reaches in relation to the pupil. Like many body part ratios, the gill raker-eye size ratios change as the juvenile salmon increases in length. For example, in specimens about 40 mm FL, the longest raker may be contained about 3 times the eye length, but in 140 mm specimens of the same species, the raker may be contained only about 2 times. This and other proportional changes must be considered.

### Anal Fin Measurement and Count

To compare the length of the fin base with the longest ray, measure the anal fin base with dividers; then project the posterior leg of the dividers forward to the opposite tip of the longest ray as shown in Figure 5 by dotted line.

In counting the number of rays (Fig. 5), do not count those anteriormost ones which are less than half the length of the longest rays, such as those marked "0." Count all rays, such as No. 1, that are half (or more than half) the length of the longest ray, taking great care to observe the last ray—No. 15 in Figure 5. The last ray is usually split to its base and appears superficially as two rays, but it is in reality only one and should be counted as such.

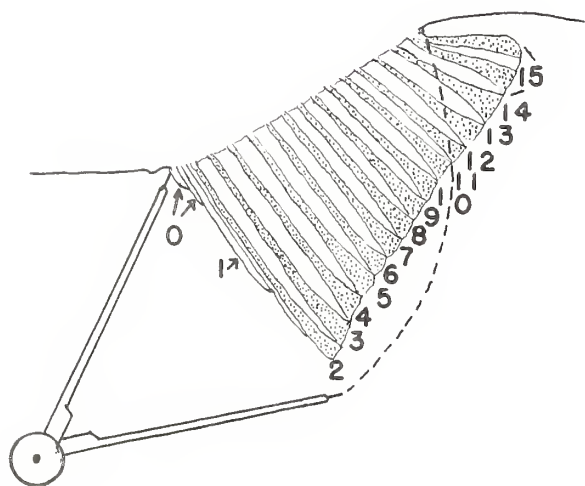


Figure 5.—Anal fin of salmon, illustrating method of measuring length of fin base and of counting rays (rays 2 to 15 are stippled here for emphasis).

### Branchiostegal Count

All branchiostegals (Fig. 6), including the smallest, anteriormost ones are counted. Usually this may be accomplished satisfactorily only under magnification and with juveniles longer than 40 mm FL. The branchiostegal count is used primarily as an additional character in specimens otherwise difficult to identify, and is especially valuable in separating the chinook salmon (usually 15 or 16) from the coho salmon (usually 13 or 14).

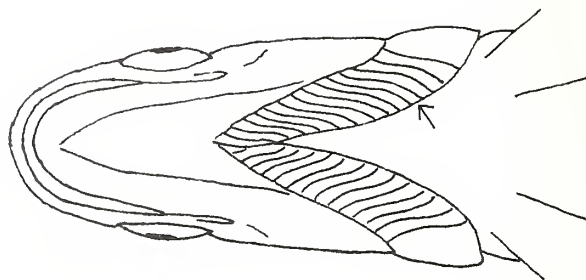


Figure 6.—Ventral surface of head of salmon. Arrow points to one of 14 branchiostegals on left side of head.

### Pyloric Caeca Count<sup>4</sup>

With a scalpel, widely open the abdominal cavity. Sever the esophagus as far forward as possible; then cut off the intestine near the posterior end of the stomach. The stomach and caeca can now be removed as a unit (Fig. 7). Use magnification and teasing needle as aids in counting. Counts of pyloric caeca are useful chiefly as an additional character for questionable specimens, especially in separating the chinook salmon (more than 100 caeca) from the coho salmon (fewer than 90).

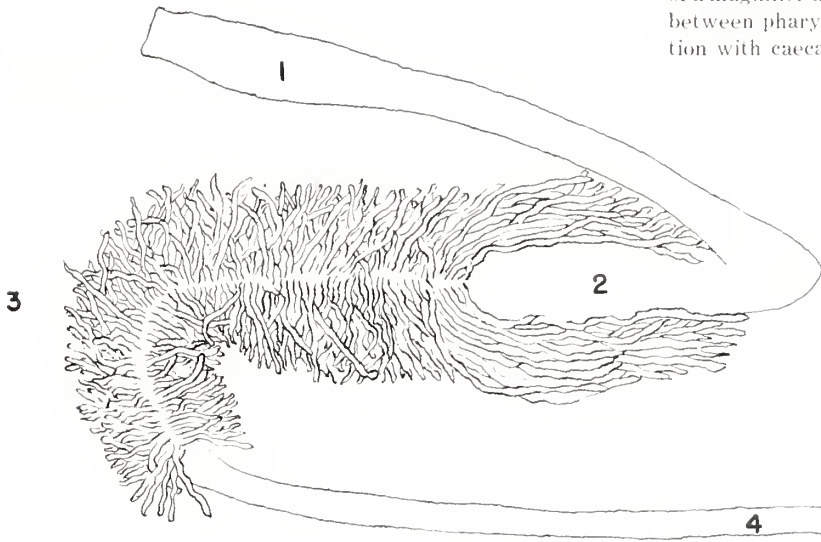
### Color Pattern Variations

Juvenile salmon from certain waters or at certain stages of development may have their parr marks or other markings masked by a bluish-

<sup>4</sup>In the key, I have used pyloric caeca counts of my own, plus published accounts of others and especially the more recent ones, such as Clemens and Wilby (1961) and McPhail and Lindsey (1970).



Figure 7.- Major portion of alimentary tract of salmon with pyloric caeca spread apart preparatory to counting with aid of a magnifier and teasing needle: 1) esophagus (part of tract between pharynx and stomach), 2) stomach, 3) pyloric section with caeca, 4) intestine.



or greenish-silvery sheen, especially when they are alive. To identify these fish, it may be necessary to preserve them first in Formalin to intensify their markings.

Juveniles of one species from certain waters, such as habitually turbid ones, may have their melanophores restricted in size or distribution, thereby resembling superficially another species. As an example, coho salmon normally have the adipose and anal fins densely speckled with rather large melanophores. But in some specimens, the melanophores may be reduced in size or distribution, so that coho salmon superficially resemble chinook salmon. Conversely, juvenile chinook salmon may have the melanophores unusually numerous and well developed, thereby resembling coho salmon. To avoid error in identification, compare the size and number of melanophores on the fins with those on the body; if few and small on the body, they should be few and small on the fins.

Color variations also occur regionally. An example is the predorsal stripe in chinook salmon, which in fish from some waters is normally a solid dark bar in specimens less than 80 mm FL; in chinook salmon in other waters the stripe may be reduced to a series of oblong blotches.

The length when individuals attain smolt coloration varies greatly, both regionally and in specimens from the same locality; some fish of

the same species may lose parr and other presmolt markings when only half as large as other fish.

## HOW TO USE KEY

Because of the variations in morphology and coloring, it is advisable to use the key in conjunction with the figures and plates and to check a large combination of characters.

In using the key, first make certain your specimen is a Pacific salmon by examining the characters under the two opposable groups labeled "1." Next, note the absence or presence of parr marks (see sections "*Combination of*" under opposable groups 2). If no parr marks are present and your specimen has not entered the silvery smolt stage, it is probably a pink salmon, but to make sure, compare it with the identifying characters between opposable groups 2. If parr marks are present, note the absence or presence of melanophores on adipose and anal fins (see groups 3). If melanophores are absent, see sections "*Combination of*" under groups 4; if present, see "*Combination of*" sections under groups 5. Decide which "*Combination of*" most closely fits your specimen, then verify it by comparing the descriptions of the identifying characters for the opposable groups.

## KEY TO PRESMOLT JUVENILE SALMON

- Salmonoid fishes having fewer than 20 rays in the dorsal fin (excludes grayling); strong teeth on jaws and tongue (excludes ciscoes and whitefishes); many pyloric caeca (excludes smelts, family Osmeridae); an axillary process or scaly appendage above pelvic fin (Fig. 1, No. 14); an adipose fin; cycloid scales; upper jaw formed by both premaxillary and maxillary . . . . .1.
- 1a Base of anal fin *shorter* than longest ray (Fig. 5). Anal rays usually 9 to 12 (rarely 8 or 13). Gill rakers normally fewer than 20 on first gill arch (Fig. 3). Dorsal fin of larger juveniles of some species with several blackish spots.  
CHAR, TROUTS, ATLANTIC SALMON. . . . .Not in this key.
- 1b Base of anal fin *longer* than longest ray (Fig. 5). Anal rays usually 13 to 17 (rarely 12, 18, or 19). Gill rakers normally 20 to 40 on first gill arch (rarely 19). Dorsal fin of larger juveniles lack blackish spots but tip of fin may be blackish.  
PACIFIC SALMON—genus *Oncorhynchus*. . . . .2.
- 2a *Combination of: No* parr marks on sides and *no* prominent specklings on back of presmolt juveniles. Usually no melanophores on anal and adipose fins; if melanophores present, they are few and very small, and if on adipose, are restricted to its posterior, free edge.  
PINK (HUMPBACK) SALMON—*O. gorbuscha*. . . . .Plate 1.
- General development—Similar to chum salmon in that yolk sac may not disappear until juvenile is more than 34 mm FL, after which development toward smolt shape and coloration is rapid. When less than 50 mm FL, this species is similar to chum salmon in being more terete than the sockeye, chinook, and coho salmon; body depth immediately before dorsal fin usually more than 1.5 times head length.
- Parr marks—Only species of salmon lacking parr marks in the presmolt juvenile.
- Coloration of body—*Preserved material*—In juveniles less than 40 mm FL, back is dark to lateral line and ventral half of body light when bicolor; dorsal third of body is darkest, sides lighter, ventral third lightest (usually milky-white or silvery) when tricolor. Few or no melanophores on lower sides and belly. In juveniles more than 40 mm FL, bicolor or tricolor condition is normally not evident, the dark back lightening gradually downward to the very light belly. *Living specimens*—Dorsal half of body bright bluish or greenish with much silvery reflection; ventral half milky or silvery-white.
- Fins—Anal and dorsal fins averaging smaller than in chum salmon; these fins in this species and in chum salmon distinctly smaller than in sockeye, chinook, or coho salmon. In specimens less than 40 mm FL the longest anal ray, when measured into head length, extends from tip of snout to about center of eye; in larger presmolt juveniles, this measurement extends from tip of snout to anterior half of eye. Anal rays usually 14 to 16 (extremes 13 to 17). *Dorsal fin* has few specklings and only a slight tendency toward a dark anterior edge in juveniles less than 50 mm FL; over 50 mm, blackish anterior edge becomes pronounced and tip of fin dusky. *Caudal fin* has speckling confined to basal half in juveniles less than 50 mm; with increasing length of juveniles, specklings appear along rays, and in large presmolt juveniles lobes tend to become blackish.

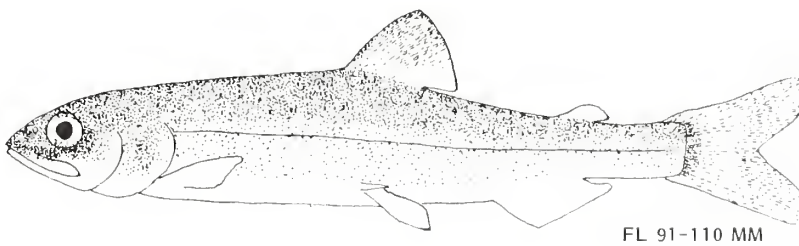
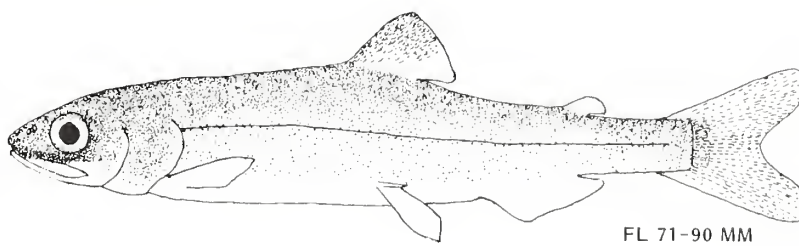
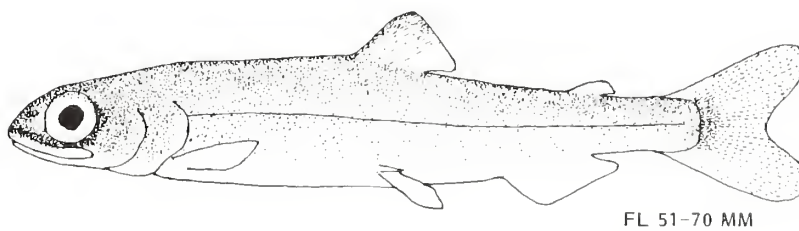
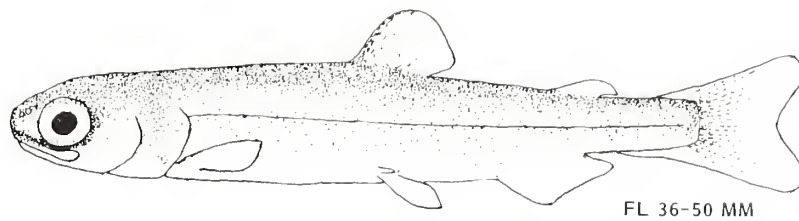
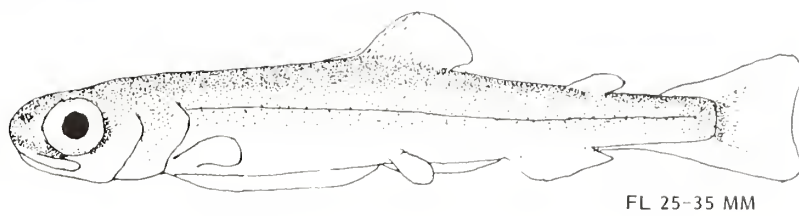


Plate 1.—Pink salmon.



Gill rakers (see Fig. 4)—Eleven to fourteen on upper limb, 14 to 19 on lower, total usually ranging between 27 and 33 (extremes 25 and 35); rakers slender and rather long; most similar in size and number to sockeye salmon but shorter and usually fewer (normally less than 31).

Pyloric caeca—Usually 130 to 195 (extremes 95 to 224); slender and rather long; differ sufficiently in numbers from coho and sockeye salmon, which have fewer than 100, to be a distinct aid in specific identification.

Branchiostegal rays—Usually 11 to 14 (rarely 10 or 15); average number less than in other species, almost invariably less than in chinook salmon, which usually has 15 to 18 (rarely 14).

Scales in lateral line—More than 170, more than in any other of the Pacific salmon; lateral line scale counts may be obtained under magnification in specimens longer than 60 mm FL.

Habits—Shortest life span of any species, between 18 mo and 2 yr. Only a comparatively small proportion of adults make extended migration in fresh water. Majority spawn in fresh waters within a short distance of brackish water or in intertidal waters. Many young enter brackish or salt waters within a few hours or days after emerging from redds, and comparatively few are found in fresh water when more than 45 mm FL.

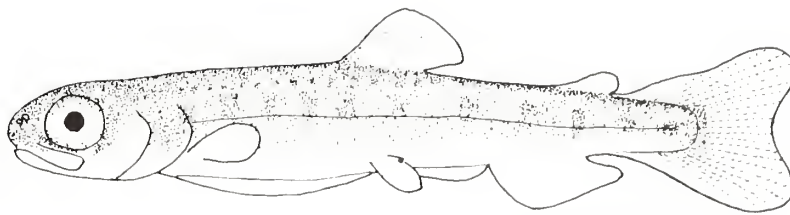
2b *Combination of:* Both parr marks on sides and dark spottings on back usually obvious in living, presmolt juveniles and always in preserved specimens under magnification (may be faint in fishes from turbid waters); parr marks become faint and disappear as juvenile assumes smolt coloration . . . . .3.

3a No melanophores normally present on adipose and anal fins of presmolt juveniles, or if present, few and quite small. Parr marks occupy a larger area above lateral line than below it, and in some specimens anterior parr marks may be almost entirely above the lateral line.  
CHUM AND SOCKEYE SALMON . . . . .4.

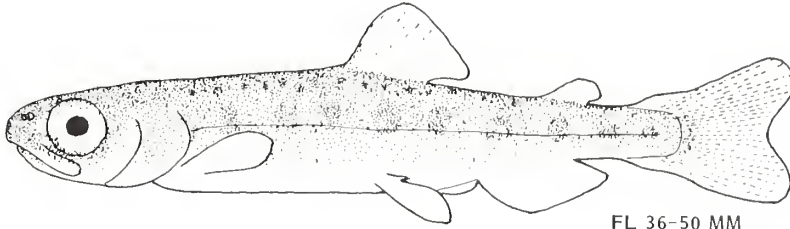
3b Melanophores normally obvious on adipose fin in living specimens and always in preserved specimens under magnification (may be indistinct in juveniles from silty waters). Anteriormost parr marks appear to occupy as large (or almost as large) an area below lateral line as above it; these parr marks are usually large, long, and wide.  
CHINOOK AND COHO SALMON . . . . .5.

4a *Combination of:* Gill rakers 19 to 26 (average 23), notably fewer and much shorter than in sockeye salmon, which have more than 28. Normally *no* melanophores on adipose and anal fins. Anterior squarish (quadrate) parr marks situated almost or entirely above lateral line in specimens less than 50 mm FL; in presmolt juveniles more than 50 mm FL, anterior parr marks tend to be long and very narrow and sometimes may extend well below lateral line.  
CHUM (DOG) SALMON—*O. keta*. . . . .Plate 2.

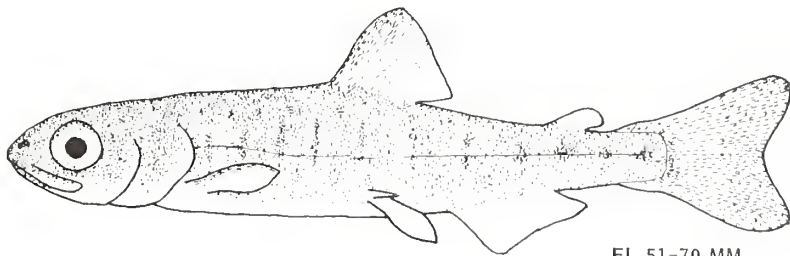
General development—Similar to pink salmon in that yolk sac may not disappear until juvenile is more than 34 mm FL, after which development toward smolt shape is rapid. Also similar to pink salmon in being more terete (when less than 50 mm FL) than the sockeye, chinook, and coho salmon; body depth immediately before dorsal fin usually 1.5 to 1.8 times head length.



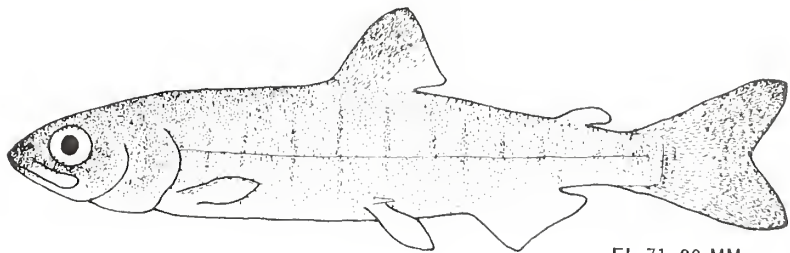
FL 25-35 MM



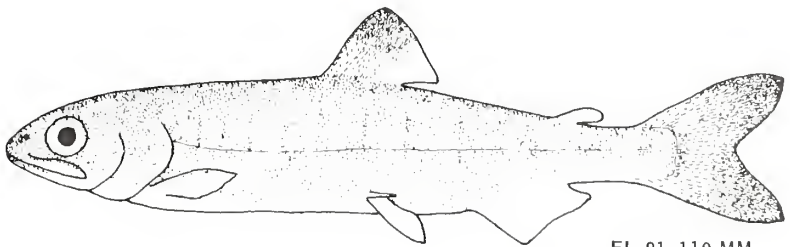
FL 36-50 MM



FL 51-70 MM



FL 71-90 MM



FL 91-110 MM

Plate 2.—Chum salmon.

Parr marks—Anterior parr marks in specimens less than 50 mm FL are more squarish (quadrate) and do not extend quite so far below lateral line as in sockeye salmon; in presmolt juveniles more than 50 mm FL, parr marks tend to become longer and more narrow than in sockeye salmon, and some tend to extend well below lateral line.

Coloration of body—*Preserved material*—Dorsal ridge stripe usually present, sometimes a series of blotches in juveniles less than 50 mm FL, becoming faint or disappearing in presmolt juveniles more than 50 mm FL; a prominent irregular row of spots and blotchings between dorsal ridge and upper edge of parr marks, these usually most distinct in specimens between 34 and 50 mm, often fading or disappearing in larger juveniles. *Living specimens*—Markings may be obscured by greenish or bluish overcast of dorsal half of body and whitish or silverish sheen of ventral half.

Fins—Anal and dorsal fins small, averaging slightly larger in size than those of pink salmon and averaging considerably smaller in height and area than those of sockeye salmon. Length of longest anal ray, when measured from snout to eye, reaches to, or almost to, center of eye; in sockeye salmon this measurement usually extends well beyond center of eye. Anal rays usually 13 or 14 (extremes 13 to 17). *Dorsal fin* has few or no distinct spottings in specimens less than 50 mm FL; in larger presmolt juveniles a dusky spot develops on tip. *Caudal fin* has faint spots largely confined to basal half in juveniles less than 50 mm FL; in larger juveniles lobes become blackish.

Gill rakers (see Fig. 4)—Seven to twelve on upper limb, 12 to 19 on lower, total usually ranging between 20 and 26 (extremes 19 to 30); rakers blunt and short, in sharp contrast to thinner, longer, and more numerous rakers of sockeye salmon, which has 30 to 39.

Pyloric caeca—Usually 160 to 185 (extremes 140 to 249); differ sufficiently in numbers from sockeye and coho salmon, which usually have fewer than 100, to be an aid in specific identification.

Branchiostegal rays—Usually 13 or 14 (extremes 12 to 16); of value primarily in separating this species from chinook salmon, which generally has more than 15.

Scales in lateral line—Between 125 and 155; of value chiefly in separating this species from pink salmon.

Habits—Life span usually 3 to 5 yr, for majority, 4 yr, some less than 3 yr. Jacks may occur. Majority spawn in fresh waters only a comparatively short distance from brackish water or in intertidal waters. Many young enter brackish or salt waters very shortly after emerging from redd, and few juveniles are found in fresh waters when more than 45 mm FL.

*Combination of:* Gill rakers 30 to 39 (average 36); notably more numerous, longer, and more slender than in chum salmon, which have fewer than 27. Normally no melanophores on adipose and anal fins. Anterior parr marks more rectangular than squarish in outline in specimens less than 45 mm FL and sometimes extend as much as a third to a half below lateral line; these oblong parr marks tend to shorten in presmolt juveniles more than 50 mm FL and to be mostly above lateral line.

SOCKEYE (RED) SALMON—*O. nerka*. . . . .Plate 3.

General development—Yolk sac usually disappears, except for trace, before juveniles reach 30 mm FL. Body deeper and species more slab-sided in all presmolt lengths than in chum and pink salmon—body depth immediately before dorsal fin usually less than 1.5 times head length.

Parr marks—See “Combination of” above.

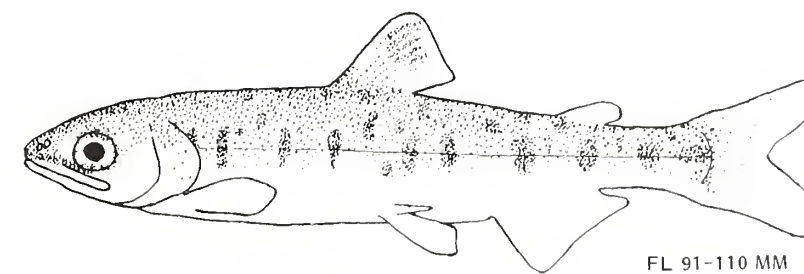
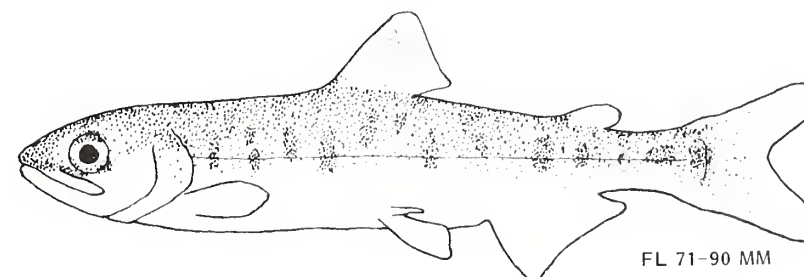
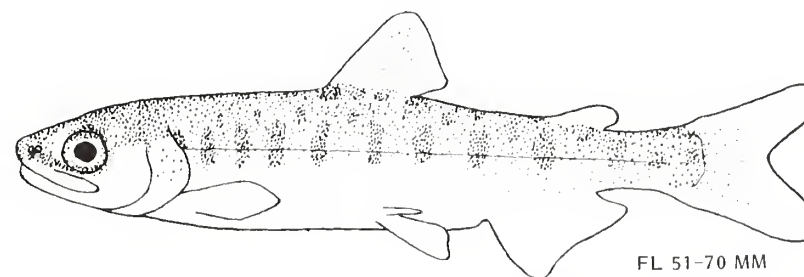
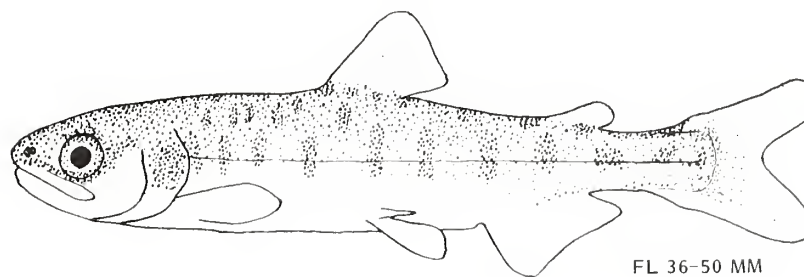
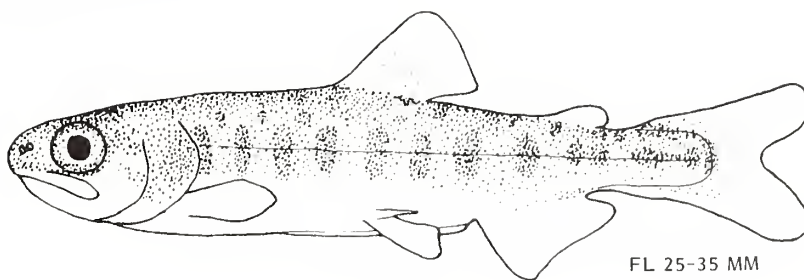


Plate 3.—Sockeye salmon.



Coloration of body—*Preserved material*—Dorsal ridge usually contains a series of more or less distinct spots in specimens less than 35 mm FL, becoming more confluent in fishes between 40 and 55 mm FL and sometimes merging into a dusky bar; in presmolt juveniles over 60 mm FL, spots or bars may disappear, after which a series of roundish spots become apparent on both sides of, and adjacent to, dorsal ridge, especially that portion behind dorsal fin; in addition to these spots, in fishes more than 35 mm FL, another longitudinal row of spots develops between dorsal ridge and upper halves of parr marks. *Living specimens*—Markings may be obscured by greenish or bluish overcast of dorsal half of body and whitish or silverish sheen of ventral half.

Fins—Anal and dorsal fins average larger in height and area than in chum and pink salmon. Length of longest anal ray, when measured from snout to eye, reaches usually from snout to beyond center of eye. Anal rays usually 14 to 16 (extremes 13 to 16). *Dorsal fin* normally has few or no distinct specklings in specimens less than 60 mm FL; a rather faint dorsal spot develops in larger presmolt juveniles in upper portion of fin, the fin being bordered on its free edges with whitish (see lowest figure, Plate 3). *Caudal fin* has few specklings on basal half, the lobes having few or no melanophores, even in rather large juveniles.

Gill rakers (see Fig. 4)—Twelve to sixteen on upper limb, 18 to 23 on lower, total usually ranging between 32 and 37 (extremes 30 to 39); rakers long and slender, averaging longer than in any other species, in sharp contrast to fewer, blunter rakers of chum salmon, which has 19 to 30.

Pyloric caeca—Usually 65 to 95 (extremes 45 to 115); usually considerably fewer than in pink, chum, and chinook salmon, and averaging more than in coho salmon.

Branchiostegal rays—Usually 13 to 15 (extremes 11 to 16); of value chiefly in separating this species from chinook salmon, which average more.

Scales in lateral line—Between 125 and 140; of value chiefly in separating this species from pink salmon, which has a higher number.

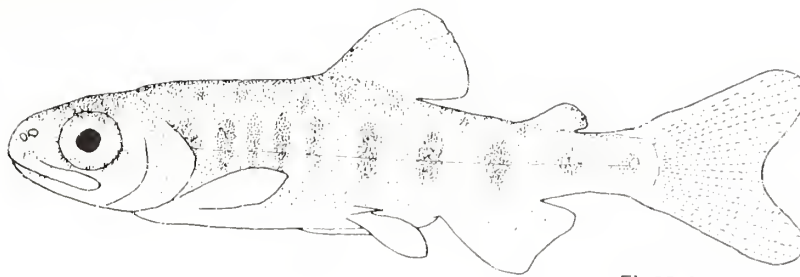
Habits—Life span usually 4 or 5 yr, some only 3. Jacks may occur. Majority of individuals highly migratory. Adults usually spawn in streams tributary to lakes; a small minority spawn in streams without a lake, in lake outlets, or on lake beaches. After rising from redd, young move downstream rather rapidly to a lake, remaining usually 1, sometimes 2, and rarely 3 yr in fresh water before entering brackish or salt water.

*Combination of:* Melanophores on adipose fin usually most numerous on posterior half and generally forming a dark border (see Plate 4); anterior half of adipose with few melanophores or none. Anal fin with few melanophores or none, but when melanophores are present, often quite large. Tip of dorsal fin and lobes of caudal fin darker in larger presmolt juveniles.

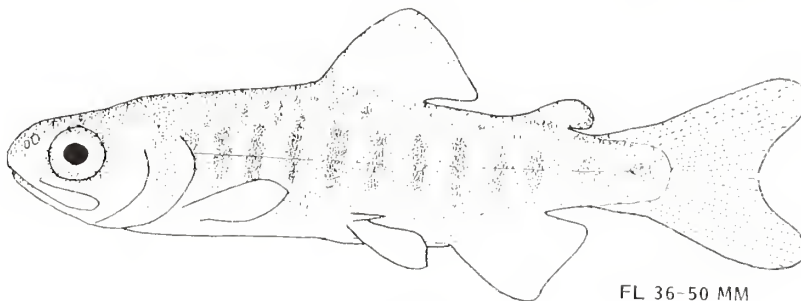
#### CHINOOK (KING) SALMON—*O. tshawytscha*. . . . .Plate 4.

General development—Yolk sac usually disappears or is reduced to a trace before juveniles reach 32 mm FL. Body deeper and species more slab-sided in all presmolt lengths than in chum and pink salmon; body depth immediately before dorsal fin usually less than 1.5 times head length (range 1.1 to 1.5).

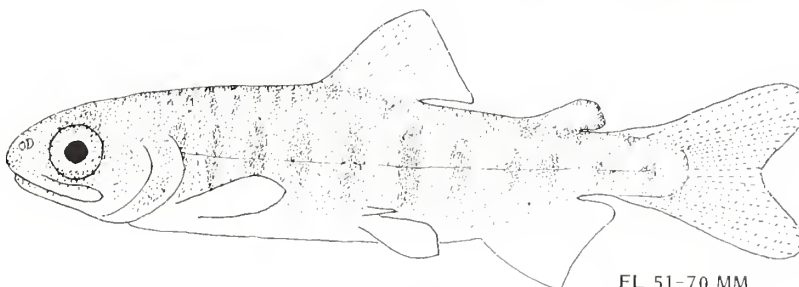
Parr marks—Almost invariably rectangular and long vertically; marks usually situated equidistant on each side of lateral line; dark parr marks and other markings contrast sharply with lighter background of body in some living and most preserved specimens.



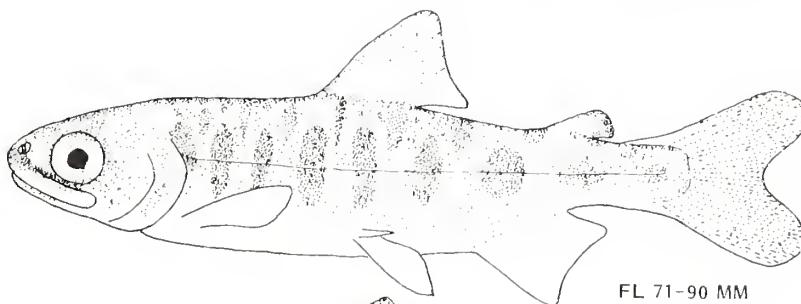
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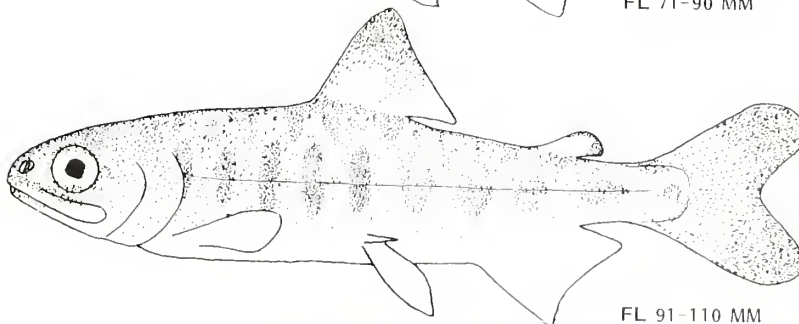
FL 36-50 MM



FL 51-70 MM



FL 71-90 MM



FL 91-110 MM

Plate 4.—Chinook salmon.

Coloration of body—*Preserved material*—Background color of body generally much lighter than body color of coho salmon, usually contrasting sharply with dark dorsal stripe or spotting, parr marks, and prominent dorsal spottings; blackish band astride dorsal ridge usually bold and unbroken in specimens less than 80 mm FL and especially on ridge before dorsal fin; in larger juveniles dorsal band often breaks up into series of spots, disappearing in larger pre-smolts as other spottings on dorsal half of body become more numerous and distinct; spottings between dorsal ridge and parr marks absent in fishes less than 35 mm FL, developing rapidly thereafter into many large and small spots and increasing in numbers as juveniles approach smolt stage. *Living specimens*—Parr marks and other markings may be obscured by bluish-silvery color of dorsal half of body and silvery sheen of ventral half.

Fins—Anal and dorsal fins averaging considerably larger in area than those of the chum and pink salmon and slightly larger than in the sockeye salmon; length of longest anal rays, when measured into head length, reaching from snout tip to beyond posterior edge of pupil and sometimes beyond posterior edge of eye; distal edge of anal slightly falcate in specimens more than 40 mm FL but averaging less falcate than does the free edge of the anal of the coho salmon. Anal rays 15 to 19, averaging higher in number than in any other species. *Dorsal fin* in young less than 60 mm FL usually has few or no distinct spottings, a blackish spot developing in the upper portion of the fin as the juveniles approach the smolt stage (see Plate 4). *Caudal fin* has comparatively few melanophores rather generally distributed in the smaller individuals, the lobes darkening as the fishes approach the presmolt stage.

Gill rakers (see Fig. 4)—Seven to twelve on upper limb, 10 to 16 on lower, total usually ranging between 20 and 25 (extremes 19 to 28); rakers short and similar in size and number to chum and coho salmon.

Pyloric caeca—Usually 140 to 185 (extremes 90 to 240); of value in separating this species from coho salmon, which normally has fewer than 85.

Branchiostegal rays—Usually 16 to 18 (extremes 13 to 19); average number greater than in any other species.

Scales in lateral line—Between 132 and 152; usually of most value in separating this species from pink salmon.

Habits—Life span 2 to 8 yr, usually 4 to 6. Jacks may occur. A portion of the juveniles enter salt water during first year of life; remainder stay in fresh waters more than 1 yr but rarely 2 yr. Juveniles of presmolt stage found in fresh waters when as long as 150 mm FL.

*Combination of:* Melanophores usually numerous and rather evenly distributed on adipose fin; occasionally in larger juveniles, posterior or free edge may be darker than remainder, thereby resembling somewhat melanophore distribution on adipose of chinook salmon. Anal fin in specimens larger than 30 mm FL more falcate and anterior tip more pronounced than in other species, including chinook salmon; in all except smallest specimens, anterior or leading edge of anal fin is whitish, with a dark bar parallel and posterior to it; remaining, posterior portion of fin usually abundantly speckled with melanophores except for distal and posterior edges (see Plate 5).

COHO (SILVER) SALMON—*O. kisutch*. . . . .Plate 5.

General development—Yolk sac usually disappears, except for a trace, before juveniles reach 32 mm FL. Body deeper and species more slab-sided in all pre-



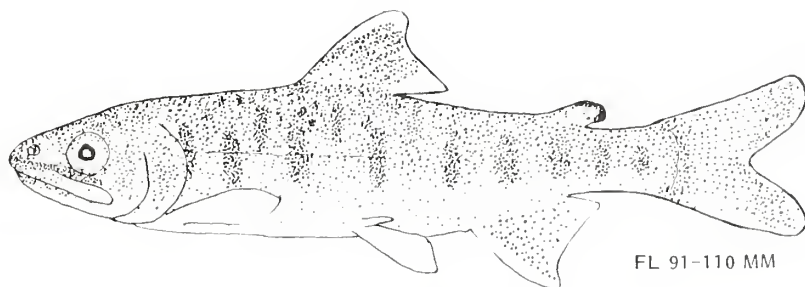
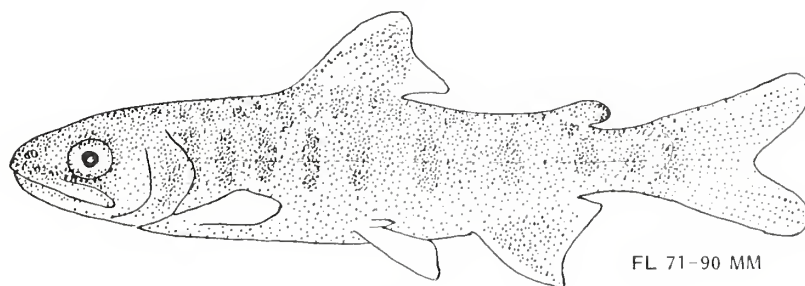
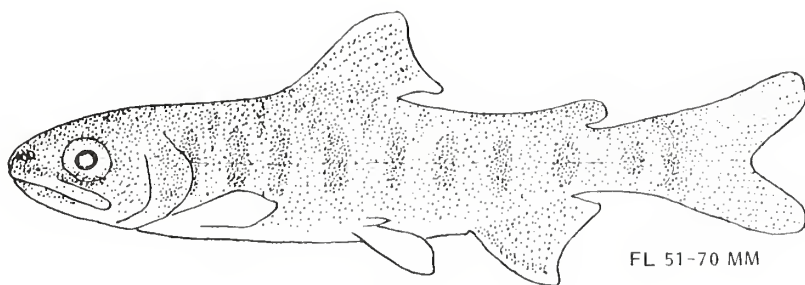
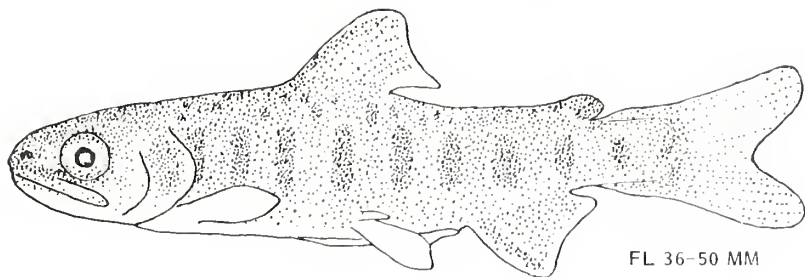
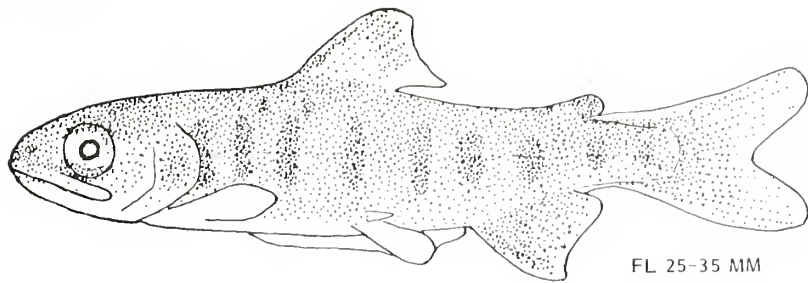


Plate 5.—Coho salmon.

- smolt lengths than in chum and pink salmon; body depth immediately before dorsal fin usually less than 1.5 times head length (range 0.9 to 1.5).
- Parr marks—Anterior parr marks always large and long vertically, their upper and lower ends more rounded than rectangular-shaped parr marks of chinook salmon; marks usually situated equidistant on each side of lateral line; usually less contrast between color of parr marks and body than in chinook salmon.
- Coloration of body—*Preserved material*—In all but smallest specimens, contrast between all body marks and background color of body is not as pronounced as in other species; dark bar along dorsal ridge usually distinct and unbroken in juveniles less than 50 mm FL, breaking up into spots or disappearing in larger specimens; back spottings on both sides of dorsal ridge usually prominent in all except smallest specimens; spots between parr marks often elongate and extending downward between them, sometimes to lateral line (see bottom figure, Plate 5); spots on dorsal half of body often increase in number and/or decrease in size as individuals approach smolt stage. *Living specimens*—Parr marks and other body markings may be obscured by dark coloration of body or by bluish sheen.
- Fins—Anal and adipose fins described under “*Combination of*” (this section). Anal rays usually 13 or 14 (extremes 13 to 16). *Dorsal fin* has comparatively few melanophores scattered over it in smallest specimens; in those more than 32 mm FL the number of melanophores increases, especially on or adjacent to anterior or leading edge; this results in a dark bar along the anterior edge behind which melanophores are rather evenly distributed; as fishes approach presmolt stage, a white anterior (or leading) edge and a whitish tip develops, followed by a dark parallel bar (see bottom figure, Plate 5). *Caudal fin* has rather even distribution of melanophores along rays in all except smallest young, this increasing in color intensity and number as fish increases in size.
- Gill rakers (see Fig. 4)—Eight to thirteen on upper limb, 9 to 14 on lower, total number usually ranging between 19 and 27 (extremes 18 to 27); rakers short and rather similar in size and number to chum and chinook salmon.
- Pyloric caeca—Usually 50 to 85 (extremes 45 to 114); of value in separating this species from chinook, pink, and chum salmon, which normally have more than 100.
- Branchiostegal rays—Usually 13 or 14 (extremes 12 to 15); average number less than in chinook salmon, which normally has 15 or more.
- Scales in lateral line—Between 120 and 140 (average 128); usually averaging fewer than in any other species.
- Habits—Life span 2 to 4 yr. Jacks may occur. Majority appear to spend 1 or 2 yr in fresh waters, a few 3 yr. Some juveniles in presmolt stage are found in fresh waters when 150 mm FL.

## GLOSSARY

*Adipose fin* A fleshy, finlike, rayless structure situated on dorsal ridge between dorsal and caudal fins (Fig. 1, No. 6).

*Anal fin* The fin situated medially and immediately behind vent between posterior end of abdomen and anterior end of caudal peduncle (Fig. 1, No. 16).

*Axillary process or scale* An accessory enlarged scale attached to upper or anterior base of pelvic fin (Fig. 1, No. 14).

*Gill opening* Opening between opercle or gill cover and side of head.

*Branchiostegals or branchiostegal rays* Elongated bones arranged fanwise within branchiostegal membranes, situated on ventral edge of gill covers (Fig. 6).

*Caudal fin* Terminal or tail fin of fishes (Fig. 1, No. 12).

*Caudal peduncle* That region of body between base of posterior ray of anal fin and base of caudal fin (Fig. 1, No. 11).

*Chromatophores* Color cells which under control of sympathetic nervous system can be altered in shape, producing color changes.

*Cycloid scales* Smooth-edged scales of soft-rayed fishes having an evenly curved posterior border devoid of minute spines.

*Dorsal fin* In salmon, a single fin composed of rays situated dorsally on body approximately halfway between head and tail (Fig. 1, No. 4).

*Dorsal ridge* Apex or dorsal junction of left and right sides of body; dorsal and adipose fins are situated on this ridge (Fig. 1, No. 3-6).

*Dorsal stripe* A band on dorsal ridge which is lighter or darker than adjacent areas.

*Falcate* Curved like a sickle; a fin is falcate when its distal edge is concave, having middle rays shorter than anterior and usually posterior rays.

*Filaments* See *gill filaments*.

*Fork length* Distance in a straight line from anteriormost part of tip of upper jaw or snout of juvenile salmon to apex of angle produced by two lobes of caudal fin (Fig. 1, No. 1).

*Gill arch* Branchial skeleton which contains gill rakers and gill filaments, or lamellae (Fig. 2).

*Gill cover, opercle, or operculum* Large, very flat, thin bones on each side of head which

cover gills (see Fig. 3, which has the major portion of the gill cover removed).

*Gill filaments (lamellae)* Pleated folds of skin, richly supplied with blood vessels, attached to posterior edge of gill arch (Fig. 2, No. 5).

*Gill rakers* Projections on anterior edge of first gill arch (Fig. 2, No. 1).

*Head length* Distance in a straight line from anteriormost part of upper jaw or snout to posterior margin of opercle (Fig. 1, No. 2).

*Hypural* Complex of expanded and fused bones of last few vertebrae which support caudal fins in certain fishes.

*Jack* Precocious male salmon which spawn after spending a year or two less in the ocean than the majority of individuals; they are notably smaller than average size of spawning males of their species.

*Juvenile* As used here, a salmon between 25 and 110 mm FL which has not entered smolt stage.

*Lamellae* See *gill filaments*.

*Lateral line* A line formed by a series of sensory tubes and pores extending along sides from head to tail (Fig. 1, No. 10).

*Lateral line scale count* A count of pored scales from first scale on body behind head posteriorly to above hypural.

*Melanophores* Chromatophores with dark or black pigment.

*Parr marks* Squarish or oblong blotches or pigmented areas along sides of presmolt salmonids (Fig. 1, No. 9).

*Pectoral fins* Anterior or uppermost of paired fins of fishes, one on each side of breast immediately behind head (Fig. 1, No. 13).

*Pelvic fins* A ventral pair of fins, abdominal in salmonids (Fig. 1, No. 15).

*Postdorsal ridge* That portion of dorsal ridge behind dorsal fin (Fig. 1, No. 5).

*Predorsal ridge* That portion of dorsal ridge before dorsal fin (Fig. 1, No. 3).

*Presmolt* A juvenile salmon with parr marks; in pink salmon, which lack parr marks, demarcation between a presmolt and smolt is slight, differing chiefly in latter's more adult shape.

*Pupil of eye* Opening in iris of eye by which light reaches retina. It is circular in fishes (Fig. 1, No. 7).

*Pyloric caeca* Fingerlike diverticula, usually glandular, which open into alimentary canal

of most fishes at junction of stomach and intestine in region of pylorus (Fig. 7, No. 3).

*Rakers* See *gill rakers*.

*Redd* Excavation or nest made by a spawning salmon.

*Rudimentary* Very small and poorly formed, pertaining here chiefly to smallest gill rakers and anal rays (Fig. 5, "0").

*Slab-sided* When depth of body, measured before dorsal fin, is considerably greater than width of body.

*Smolt* As used here, a young salmon which has lost its parr marks. Pink and chum salmon fry usually go to the ocean within a few days of emerging from the streambed and usually do not undergo a visible change in morphology or color in fresh water.

*Subadult* An individual similar to an adult and approaching adulthood in age and size but still incapable of breeding.

*Terete* Nearly cylindrical in cross section and tapering toward the front and rear.

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